Digital Cameras and Pictures

What is a Pixel?

a picture element, - "the smallest complete sample of an image". The key here is that we are talking about the smallest element in an image: that is, the final picture or photograph. Obviously, a digital photograph is made up of millions of tiny points of light, each of which can have its own unique color and brightness. When these points of light are displayed next to one another and viewed from a distance, the individual points of light fade together and we see what appears to be a smooth, continuous image. There are various ways to represent color and brightness for each point of light or pixel in the image, but the most common is to assign each pixel its own set of red, green, and blue brightness values since you can reproduce a particular color by combining red, green, and blue intensities. A pixel then, must have all three (red, green, and blue) components to be a complete sample of the final image.

Sensor Photosites and Pixels?

Ever since images from digital cameras broke the **one million pixel** boundary, the term "megapixel" has been used to describe resolution. Using this term, buyers could get an idea about how large they could **print**, how much leeway they would have to **crop images**, and so on. While a "10 megapixel" claim is accurate with respect to how many pixels are in the **final (developed) image**, somewhere along the way, the megapixel moniker has gotten confused with "**camera resolution**". A typical camera claimed to be a 10-megapixel digital camera may **produce** 10 megapixel images, but by definition, the camera itself (the sensor) does not contain 10 million pixels. Far from it in fact! This "10-megapixel digital camera" actually contains **no pixels whatsoever on its sensor**. Instead, the sensor is a **conglomerate of 5 million green photosites, 2.5 million red photosites, and 2.5 million blue photosites**. Sophisticated software takes information from these 10 million individual samples of red, green, OR blue at each location in order to **predict** the missing two-color channels at each pixel in the **final image**. Since a pixel is defined as a complete picture element, a typical digital camera cannot be defined as a "10-megapixel camera" even if it produces a 10-megapixel final image because two thirds (67%) of that 10-megapixel final image is "**predicted" rather than actual data**. For the camera itself to be called 10 megapixels, it must have 10 million photosites on the sensor, each of which is able to represent complete information **without borrowing** information from neighbors.

Enter Full Color Capture?

For a long time, none of this pixel definition nit-picking mattered because all cameras were roughly the same. They all captured only one of the three red, green, or blue colors at each location on the sensor and they all predicted the missing two colors by looking at neighboring locations on the sensor and predicting. The fact that your 10 million pixel image didn't come from a 10 million photosite camera didn't matter because everyone was compared on a level playing field. When Sigma introduced the first consumer full capture camera (the SD9) in 2002, they were faced with a dilemma. Should they call it a 3.5 megapixel camera because it delivers 3.5 million pixel final images, or should they call it 10 megapixels since it captures all three red, green, and blue color primaries at each location on the sensor? Technically (by the definition of a pixel), they should label it as a 3.5 megapixel camera but its competition at the time were cameras dubbed as 6 megapixels even though they were not really 6

megapixel cameras. Now that technology was changing, the "fuzzy" definition of megapixel that had worked for years suddenly broke down. People started picking sides and arguing apples versus oranges.

Then, still a long time ago, Sigma's updated SD14 produces a 4.6 megapixel final image from 4.6 million sensor photosites. Once again, Sigma was faced with how to label their product since the competition was calling their cameras 8 and 10 megapixel yet those cameras recorded no true pixels at all and the final 8 or 10 megapixel image had to be extracted from mathematical programs. Had Sigma called their SD14 a 4.6 megapixel camera, most consumers wouldn't realize that since the camera captures full color, its final images are comparable to images from typical (non full color) 10 megapixel cameras. They chose instead to take the "high road" and label it a 14 megapixel camera figuring that if the rest of the industry can claim 10 megapixels when only one third of each pixel is real data, they can claim 14 megapixels when they are capturing all three primary colors (4.6 x 3). In reality, Sigma marketing was fighting misleading terminology with more misleading terminology. They likely felt they needed to because it was easier than reeducating the public.

Is this making sense yet?

People can claim that calling a 4.6 megapixel full capture camera 14 megapixels is hype when no one complains that a camera advertised as 10 megapixels can't deliver 10 megapixels of real image information. What's the real hype here: the fact that the SD14 is really 4.6 megapixels and not 14, or the fact that a typical camera labelled 10 megapixel really only captures one third of the information at each pixel? Both technologies work and one is not necessarily better than the other for all things, but when comparing megapixel numbers on paper, it's beneficial to note that the term "megapixel" is used rather loosely in this industry.

More

Single color capture cameras, particularly those with the Bayer RGB design, try to replicate how the human eye works, giving more resolution to green and less to blue and red. The goal of any imaging device should be to produce the highest quality photographs possible and reproducing the most accurate information for each pixel is how we accomplish that task. This is how, resolution-wise, full color capture cameras like the SD14 can compare nicely to single color capture cameras with much higher final image resolution.

What is a full and crop Sensor?

A camera sensor is considered “full” if it is the size of the old 35mm film standard. Crop sensors are those that are smaller than full size and are in most consumer DSLRs. Canon’s DSLRs come in a few flavors of sensor sizes, but the two primary sizes are called Full and APS-C size. If you have a Rebel, you have an APS-C sized sensor.

Should You Care?

In short, no. There are only two reasons you may care, 1) You used to shoot 35mm film cameras and your brain is still wired this way, 2) you are considering buying another camera with a sensor size different from the one you own. If you are considering moving up to say a full frame camera, you do have to keep in mind that what a 200mm lens does for **zooming** is not going to be the same as your crop sensor camera. You will lose zoom power and have to rethink the value of your lens collection, assuming your lenses will even fit on a full frame camera.

Zoom, Sensor Size, and Crop Factor

When a camera has a smaller sensor, it will appear to have more zoom than a full sensor camera with the same size lens. Many folks who want more reach, like crop sensor cameras because images look closer given the same lens.

Sensor Size and Image Quality

This is a very misunderstood issue and in short, all the DSLRs on the market today have great image quality. To hit a price point or satisfy the desires of a target market, engineers make many tradeoffs and to make matters even more difficult, the state of the art is always advancing so what is true today may not be true tomorrow. But to give you a quick answer, the following is mostly true:

Full or larger sensors are generally considered to have superior image quality than smaller sensors

Full sensors provide for a shallower depth of field than crop sensors and are therefore desired by those who want to create arty pictures with blurred backgrounds

Crop, or smaller sensors, are desired by those who want more reach or zoom for their dollar

Larger sensors tend to be less noisy and have better high ISO performance than smaller sensors

Larger sensors are way more expensive to manufacture than smaller ones and the cameras that have them are very expensive

Smaller sensors do not require the larger lenses of full sensor cameras so manufacturers created a line of smaller, less expensive lenses for these cameras.

Conclusion

Pictures are images that are produced from light hitting Photosites on a sensor and then the red, green and blue from that light is converted into **pixel data** via a **mathematical algorithm**, this creates a best guess to recreate what you were looking at before you clicked the button on your camera, then its displayed on a cell phone or computer monitor or wherever. The resolution and size of the final viewing device has the final say in how well the picture appears to the eye in technical form no matter how expensive the camera cost.

Light hits a sensor containing Photosites which is then processed by a tiny computer chip and converted into pixels which are then sent to an output device.

In the beginning of all of this technology, the word pixel and photosite were used interchangeably. Recently, photosite is being used as a term for the sensor that captures an image and pixel is being used as the term that outputs an image to a device.